"EFFECTIVENESS OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION OVER PASSIVE STRETCHING IN REDUCING SPASTICITY ON PLANTAR FLEXORS IN PATIENTS WITH HEMIPLEGIA – A COMPARATIVE STUDY"

A Dissertation Submitted in the partial fulfillment of the requirement for the Degree of

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With specialization in

ADVANCED PHYSIOTHERAPY IN NEUROLOGY

Submitted by

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(AFFILIATED TO THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY)

SALEM

CERTIFICATE

This is to certify that the project entitled a report on **"EFFECTIVENESS OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION OVER PASSIVE STRETCHING IN REDUCING SPASTICITY ON PLANTAR FLEXORS IN PATIENTS WITH HEMIPLEGIA – A COMPARATIVE STUDY"** submitted by **(REG No: 27092404)** is a bonafide work done in the partial fulfillment of requirement for the **MASTER OF PHYSIOTHERAPY** course with Advanced Physiotherapy in Neurology as Specialization of The Tamilnadu Dr. M.G.R. Medical University, Chennai -32.

Guide **Principal**

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1. INTRODUCTION

Stroke is a clinical syndrome resulting due to sudden loss of neurological function caused by an interruption of the blood flow to the brain. According to The World Health Organization (WHO), Stroke is defined as ‘rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24hrs or longer, or leading to death, with no apparent cause other than of vascular origin.

Stroke is the third leading cause of death and most common cause of disability. The prevalence rates of stroke vary from one study to another. The incidence of stroke is 1.25 times greater for males than females. The incidence of stroke increases with age, doubling in the decades after 65 years of age.

Symptoms of the stroke start suddenly over seconds to minutes, which in most cases does not progress. In stroke, a variety of focal deficits are possible, including changes in conscious level and impairments of sensory, motor, cognitive, perceptual and language functions. These neurological deficits must persist for at least 24 hours to be classified as stroke.

The motor deficits are characterized by paralysis (hemiplegia) or weakness (hemiparaesis), typically in the side of the body opposite to the side of the lesion.

In intracranial hemorrhage, the affected area may compress other structures. Most forms of stroke are not associated with headache, apart from subarachnoid hemorrhage and cerebral venous thrombosis and occasionally intracerebral hemorrhage.

RISK FACTORS

The major risk factors for stroke are hypertension, heart siseases and diabetes. Some of the modifiable risk factors include smokingkm obesity, lack of exercise, diet and excess alcohol consumption.

If the area of the brain affected contains one of the three prominent central nervous system pathways - the spinothalamic tract, corticospinal tract, and dorsal column (medial lemniscus), symptoms may include:

- Hemiplegia and muscle weakness of the face
- Numbness
- Reduction in sensory or vibratory sensation

Stroke affecting the brain stem can produce symptoms relating to deficits in these cranial nerves:

- Altered smell, taste, hearing, or vision
- Drooping of eyelid (ptosis), weakness of ocular muscles
- Decreased reflexes- gag, swallow, pupil reactivity to light
- Decreased sensation & muscle weakness of the face
- Nystagmus and Balance Problems
- Altered breathing & heart rate
- Sternocleidomastoid Muscle weakness with inability to turn head to one side
- Weakness in tongue (inability to protrude and/or move from side to side)

Stroke affecting cerebral cortex also can produce the following symptoms:

- Aphasia (inability to speak or understand language from involvement of Broca's or Wernicke's area)
- Apraxia (altered voluntary movements)
- Visual Field defect
- Memory deficits (involvement of temporal lobe)

- Disorganized thinking, confusion, hypersexual gestures (with involvement of frontal lobe)
- Anosognosia (persistent denial of the existence of disease, usually stroke-related, deficit)

If the cerebellum is involved, the patient may have the following:

- Trouble walking
- Altered movement coordination
- Vertigo and or disequilibrium

ASSOCIATED SYMPTOMS

Loss of consciousness, headache, and vomiting which usually occurs more often in hemorrhagic stroke than in thrombosis because of the increased intracranial pressure from the leakage of blood compressing the brain.

PATHOPHYSIOLOGY

ISCHAEMIC

In cerebrovascular disease atherosclerosis is an important factor, which is characterized by plaque formation with an accumulaton of lipids, fibrin and calcium deposits on arterial walls leading to narrowing of blood vessels.

Interruption of blood flow by atherosclerotic plaques leads to ischaemia and thereby causing infarction of the brain cells (Ischaemic stroke).

The complete cerebral circulatory arrest results in irreversible cellular damage with a core area of focal infarction within few minutes. The transitional area surrounding the core is known as ischaemic penumbra. Ischaemia initiates a number of damaging and potentially reversible events, termed ischaemic cascade.

The inability of brain cells to produce energy (ATP) is due to excess release of neurotransmitters (glutamate and aspartate). This is followed by excess influx of calcium ions and pump failure of neuronal membrane. This excess calcium reacts with intracellular phospholipids to form free radicals, it also stimulates the release of nitric oxide and cytokines, these two mechanisms further damage the brain cells.

HAEMORRHAGIC

Haemorrhagic strokes are due to abnormal bleeding into the extravascular areas of the brain as a result of rupture of cerebral vessels or due to trauma. Haemorrhage leads to increased intracranial pressures with injury to brain tissues and restriction of blood flow.

DIAGNOSIS

Stroke is diagnosed through several techniques: a neurological examination, CT scans or MRI scans, Doppler ultrasound, and arteriography. The diagnosis of stroke itself is clinical, with assistance from the imaging techniques. Imaging techniques also assist in determining the subtypes and cause of stroke. There is yet no commonly used blood test for the stroke diagnosis itself, though blood tests may be of help in finding out the likely cause of stroke.

SPASTICITY

Brain injury due to stroke sometimes causes muscles to involuntarily contract when you try to move your limb, this creates stiffness and tightness known as spasticity. Spasticity is also characterized by efferent symptoms such as delayed and disrupted muscle synergies (e.g. co-contractions) or remote involuntary (associated) muscle activity during active movements as well as by afferent symptoms such as massive flexion or extension reactions to touch or pain stimuli.

Spastic muscles may have many other potential features of altered performance in addition to spasticity, like muscle weakness; decreased movement control; clonus (a series of involuntary rapid muscle contractions

which are repeated spastic stretch responses) exaggerated deep tendon reflexes and decreased endurance.

Spasticity can greatly interfere with the functional use of the affected body parts, in particular when spastic antagonists counteract selective voluntary muscle activity. In the long term, untreated spasticity may lead to secondary complications such as muscle stiffness, contractures and pain. In the upper extremity of stroke patients, spasticity most frequently emerges in a predominant flexion pattern. It may cause great difficulty with arm or hand positioning in space, grasping, self-care and many other activities of daily living (ADL).

When the tendons and soft tissue surrounding it can become tight a muscle can't complete its full range of motion, thereby stretching the muscle becomes much more difficult. If we do not treat spasticity, the muscle can freeze permanently into an abnormal and often painful position.

MUSCLE TONE ASSESSMENTS

Spasticity is assessed by using the Modified Ashworth Scale (MAS). This scale grades the resistance of a relaxed limb to rapid passive stretch in 6 stages. Zero denotes normal or lowered muscle tone and 4 denotes a state in which passive movement of the affected limb is impossible. In this study, we

tested arm adductors, elbow flexors and extensors, wrist flexors and extensors, and finger flexors with the patient in a sitting position if possible; we also tested hip adductors, knee flexors and extensors, and plantar flexors in patients in the supine position.

The MAS is considered fairly reliable, seventeen Self-reported muscle stiffness was assessed by asking the patients if they experienced increased muscle stiffness somewhere in the body. The deep tendon reflexes were tested on the biceps and triceps of the upper extremities and the patellar and tendocalcaneous on the lower extremities with the help of a reflex hammer. Plantar flexor tone was additionally assessed by counting the number of clonic beats.

In rehabilitaton medicine the management of spasticity remains a major challenge. The available treatment options include various physical methods like muscle lengthening, splinting, and electro stimulation, systemic use of spasmolytic drugs, soft tissue surgery include muscle-tendon lengthening or transposition, tenotomy, neurectomy as well as several invasive procedures for focal neuronal or neuromuscular blockade (4–13). The ideal treatment strategy would be to achieve a long-lasting relief of disabling hypertonia in selected groups of muscle without causing impairment of sensation, deterioration of motor skills, or other local or systemic side-effects

The use of electric current produced by a device to stimulate the nerves for therapeutic purposes is known as Transcutaneous electrical nerve stimulation (TENS). TENS implies the complete range of transcutaneously applied currents used for nerve excitation although the term is often used with a more restrictive intent, namely to describe the kind of pulses produced by portable stimulators used to treat pain. The apparatus is usually connected to the skin using two or more electrodes.

TENS is applied at a high frequency of >50 Hz with an intensity below motor contraction (sensory intensity) or at a low frequency <10 Hz with an intensity that produces motor contraction. A battery-operated TENS unit is able to modulate pulse width, frequency and intensity.

Passive stretching is a form of static stretching in which an external force exerts upon the limb to move it into the new position. This is in contrast to active stretching. Passive stretching resistance is normally achieved through the force of gravity on the limb or on the body weighing down on it. It can also be achieved with the help of a partner, stretch bands, or mechanical devices.

1.1. NEED FOR THE STUDY

Hemiplegia is a condition in which spasticity in the body musculature greatly affects the functional independence of the patients. Various studies have been done previously to find the effective means to reduce the spasticity. TENS and passive stretching were also been studied for its efficacy. Both the methods have shown favorable results in reducing spasticity. However their individual effectiveness over the other is required to be studied.

In this study an attempt has been made to find out the effectiveness of TENS over passive stretching in reducing spasticity on plantar flexors in patients with Hemiplegia.

1.2. STATEMENT OF THE PROBLEM

A study to analyze the effectiveness of TENS over passive stretching in reducing spasticity on plantar flexors in patients with hemiplegia

1.3 KEY WORDS

- Spastic hemiplegia
- TENS
- Passive stretching

1.4 OBJECTIVES OF THE STUDY

The main objectives of the study were

1. To find out the effect of High frequency transcutaneous electrical nerve stimulation in reducing spasticity for hemiplegic patients.
2. To find out the effect of passive stretching in reducing spasticity for hemiplegic patients.
3. To compare the effectiveness of High frequency transcutaneous electrical nerve stimulation over passive stretching in reducing spasticity in patients with hemiplegia.

1.5 HYPOTHESIS

NULL HYPOTHESIS

There is no significant difference in reducing spasticity on plantar flexors in patients with hemiplegia using Transcutaneous electrical nerve stimulation over Passive stretching.

ALTERNATE HYPOTHESIS

There is a significant difference in reducing spasticity on plantar flexors in patients with hemiplegia using Transcutaneous Electrical Nerve Stimulation over Passive Stretching.

2. REVIEW OF LITERATURE

Chung SG et al, 2004

They conducted a study to find the biomechanical changes in the passive properties of hemiplegic spastic ankles using 24 stroke patients with spastic ankles and 32 healthy controls. They exhibited passive resistance torque at controlled dorsiflexion and plantarflexion positions that were stretched for 10 minutes. They correlated with the Modified Ashworth Scale at $p<0.01$ and concluded that the various measures can be potentially used to obtain more comprehensive and quantitative evaluations of spastic hypertonia in a clinical setting.

Guissard N and Duchateau J, et al 2004,

They conducted a study on the effect of static stretch training on neural and mechanical properties of the human plantar flexor muscles in 12 subjects and found that there was a change in flexibility of the muscle and the stiffness reduced. They concluded that increased flexibility results mainly from reduced passive stiffness of the muscle-tendon unit and tonic reflex activity

Armutlu K et al, 2003

They conducted a pilot study in the School of Physical Therapy, Ankara, Turkey on the effect of Transcutaneous Electrical Nerve Stimulation on spasticity in 10 patients with multiple sclerosis by giving a stimulus of frequency 100 Hz and pulse width 0.3millisecond for 20 minutes per day for a period of 4 weeks. The results showed significant reductions in spasticity in both the extremities.

Eadric Bressel et al, 2002

Have done their study on the effect of prolonged static and cyclic stretching on the ankle joint stiffness, torque relaxation and gait in people with stroke. They concluded that ankle joint stiffness decreases after both prolonged static and cyclic stretching, although neither technique appeared to be better at reducing stiffness in people with stroke.

Yeh CY et al, 2004

They conducted a study on the quantitative analysis of ankle hypertonia after prolonged stretch in subjects with stroke. They gave stretching for 30 minutes using constant force that is approximately 80% of the torque and finally concluded that the application of prolonged muscle stretch with a

constant torque could reduce not only the elasticity of the hypertonic muscles but also their viscosity

Susan Morris, et al 2002

She have conducted a study about the clinical relevance of Ashworth and Tardieu scales for measuring spasticity in adult and pediatric neurological populations. An extensive search of the literature revealed that both the scales have been used to assess spasticity in adult and pediatric patients with content validity and reliability

Guissard N et al, 2001

They have conducted a study by recording the electromyographic responses of the soleus muscle while electrically stimulating the tibial nerve at the popliteal fossa and at the ankle and performing passive muscle stretching. The results indicated that reduced motor neurone excitation during stretching is caused by pre- and postsynaptic mechanisms.

Hinderer SR and Dixon K, et al 2001

They conducted a study about the physiologic and clinical monitoring of spastic hypertonia in the Department of Physical Medicine and Rehabilitation, Rehabilitation Institute of Michigan, Detroit, Michigan, USA. They suggested

that spasticity must be systematically approached with evaluation and treatment of it. They also quoted that the potential risks and side effects of treatment options must be weighed versus the potential benefits that the patient might receive to maintain a rational approach to the management of spasticity

Lee SJ et al, 2001

They have analyzed the effect of passive stretching on the spasticity of ankle plantar flexor muscles in the Department of Rehabilitation Medicine, Dankook University, Korea using twenty two ankle joints of nineteen patients with upper motor neuron lesions and modified Ashworth scale was used for clinical assessment. They finally concluded that the passive stretching of ankle plantar flexor muscles decreased the stretch threshold, that is a neural component of spasticity but it did not decrease the mechanical component of spasticity

Tsai KH et al, 2001

They conducted a study in the Southern Taiwan University of Technology, Tainan, China to find the effect of single session of prolonged muscle stretch on the spastic muscle in which they took seventeen subjects. Following the stretching protocol they found those 30 minutes of prolonged muscle stretching is effective in reducing motor neuron excitability of triceps

surae in spastic hemiplegia, thus providing a safe and economical method for training stroke patients

Rodrigues CM et al, 2000

They conducted a study about the effects of transcutaneous electric stimulation in the reduction of spasticity of the spinal cord injured patients in the Department of Physical Medicine, University of Vale, Brazil. They considered four volunteers with uncompleted spinal cord injury and treated them with transcutaneous electrical nerve stimulation with variation in frequency and intensity. The results showed a significant reduction in the tone of the spastic muscles after electrical stimulation

Sonde L et al, 2000

They conducted a study on the effects of stimulation with high frequency Transcutaneous Electrical Nerve Stimulation on lower limb spasticity after stroke applied TENS for 16 subjects over acupuncture points of the anti-gravity muscles. A significant reduction of spasticity was seen after the completion of treatment. The results of their study suggested that stimulation of the acupuncture point with high frequency TENS could be a clinical method to reduce spasticity in paretic leg after stroke

Tekeoglu Y et al, 1998

They conducted a study to find the effectiveness of Transcutaneous Electrical Nerve Stimulation in the Department of Physical Medicine, Van, Turkey on Barthel activities of daily living index score following stroke by dividing the subjects in to two groups of 30 each. One group received TENS with a frequency of 100Hz whereas another group was given placebo TENS and found that the group which received high frequency Transcutaneous Electrical Nerve Stimulation had a remarkable reduction in spasticity.

Goulet CG et al, 1997

They did a study to find the effectiveness of Transcutaneous Electrical Nerve Stimulation on the reflex of muscles of different fiber type composition in the Faculty of Health Sciences of University of Otta. They applied TENS over different muscles like soleus and gastrocnemius. Although their study failed to reveal any different effects of TENS on the H reflex amplitude of the muscles on different fiber type content, the significant decrease in H reflex observed on the triceps surae muscles during TENS applied over the sural nerve had promising clinical outcome for the hyper reflexive subjects

Han JS et al, 1994

They conducted a study about the transcutaneous electrical nerve stimulation for treatment of spinal spasticity considering thirty two patients with spinally originated muscle spasticity. They received high frequency stimulation of 100Hz for a period of three months and the results showed a remarkable reduction in the tone of spastic muscle groups

Hui-Chan CW and Levin MF, et al 1993

Their study on stretch reflex latencies in spastic hemiparetic subjects using Transcutaneous Electrical Nerve Stimulation in the School of Physical Therapy, Montreal, Canada found that the application of low intensity TENS decreases spasticity and improves voluntary motor control. They also added that TENS applications enhanced vibratory inhibition of the H reflex and decreased the hyperactive stretch reflexes. In their results they insisted that repeated application of Transcutaneous Electrical Nerve Stimulation could reduce clinical spasticity and improve control of reflex and motor functions in hemiparetic subjects

Levin MF and Hui-Chan CW, et al 1997

They have conducted a study on hemiparetic spasticity by using Transcutaneous Electrical Nerve Stimulation. They found that the application of TENS prolonged the soleus H stretch reflex latencies in hemiparetic subjects. They also added that TENS applications enhanced vibratory inhibition of the H reflex and decrease the hyperactive stretch reflexes. In their results they insisted that repeated application of Transcutaneous Electrical Nerve Stimulation could reduce clinical spasticity and improve control of reflex and motor functions in hemiparetic subjects.

Tremblay F et al, 1990

They have conducted a study on the short-term effects of a single session of prolonged muscle stretch on reflex and voluntary muscle activations in 22 children with spastic cerebral palsy in the Neurobiology Laboratory, Laval University, Canada. They assigned the children into two groups namely experimental and Control groups; the effects were studied by electromyography. The results indicated that prolonged muscle stretch led to reduced spasticity in the ankle muscles as demonstrated by the significant reductions of the neuromuscular responses to passive movement. The inhibitory effects lasted up to 35 minutes after cessation of muscle stretch.

Potisk KP et al

They have conducted a study on the effects of transcutaneous electrical nerve stimulation (TENS) on spasticity in patients with hemiplegia considering 20 patients with chronic hemiplegia after stroke. They concluded that TENS has got short-term post-stimulation inhibitory effects on the abnormally enhanced reflex activity in spasticity of cerebral origin.

Yu Y, et al

Have conducted a study on the effect of TENS at acupoints in the treatment of spinal spasticity. The short term application (30min) of high-frequency TENS of 100Hz produced an immediate antispastic effect in contrast to the low-frequency one. After a period of 3 months antispastic effect was stable in case of high frequency TENS.

3. MATERIALS AND METHODOLOGY

MATERIALS

1. Treatment couch
2. Pillows & towels
3. Mackintosh Sheets
4. High frequency TENS apparatus
5. Two surface rubber-carbon electrodes with leads
6. Electrode Gel
7. Velcro Straps
8. Cotton

METHODOLOGY

3.1 STUDY DESIGN

Experimental –Comparative study

3.2 STUDY SETTING

This Study was conducted at the Department of Physiotherapy Shanmuga Institute of Post graduate Medical Sciences, Salem-7 under the supervision of concerned authority.

3.3 STUDY DURATION

- 8 weeks

3.4 SUBJECTS

- Simple Random Sampling
- A total number of 60 subjects were screened out of which 20 subjects were selected for the study. Each patient was screened initially by using a simple selection proforma relevant to the inclusion and exclusion criteria. Those who fulfilled these symptomatic criteria underwent a detailed physical examination. Then the selected patients who were willing to participate were randomly divided into two groups of 10 each in Group A and Group B. The details and the purpose of the study were

explained to all the patients and informed consent was obtained and demographic data were collected from each patient.

Group A

Hemiplegic patients with plantarflexor tightness (7 females and 3males) were treated with TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION.(TENS)

Group B

Hemiplegic patients with plantarflexor tightness (6 males and 4 females) were treated with PASSIVE STRETCHING.

3.5 CRITERIA

3.5.1 INCLUSION CRITERIA

1. Hemiplegic stroke patients graded as stage III & IV according to Brunnstrom's classification.
2. Both male and female subjects.
3. Age group between 50-60 years.
4. Patients with spasticity in the plantar flexors of the ankle joint.
5. Duration of the condition: up to six months from onset.

3.5.2 EXCLUSION CRITERIA

1. Hemiplegic stroke patients graded as recovery stage I, II, V & VI of Brunnstrom's recovery stage.
2. Age group: below 50 years and above 60 years.
3. Duration of the condition more than 6 months.
4. Patients with cognitive and perceptual disorders
5. Patients with cardiac & musculoskeletal abnormalities, head injuries and fractures of lower limb.
6. Patients with an history of vascular diseases in the lower limb & Diabetic foot

3.6 PARAMETERS

MODIFIED ASHWORTH SCALE

The objective assessment of spasticity was done using this scale. The patient was examined lying on a couch in a relaxed position and the affected lower limb was moved passively. The resistance encountered by the therapist to passive movement was then recorded using modified scale of Ashworth, the scale has been mentioned in detail in Annexure - 4

PROCEDURE

All the subjects who fulfilled the selection criteria alone were selected and assigned to Group A and Group B in a random manner. The patient was fully informed about the treatment procedure and the informed consent was taken. The general condition of the patient was assessed before subjected to the treatment. The patients were sorted out in to two groups called Group I and Group II. Each group consisted of 10 subjects.

Apart from this, Conventional physiotherapy such as passive movement was given to both the groups. This was given once in a day for the ankle joint throughout the study period.

The patients of **Group A** were prepared according to the electrotherapy treatment. Before starting with the treatment session, presence of any contra indications was checked. The skin resistance was lowered by washing the treatment area with soap water and excessive hair was removed if it seemed to reduce the conduction of the current.

Patient was positioned in prone lying with a pillow beneath the anterior aspect of leg. Four carbonized rubber electrodes were used to stimulate the area. Ultrasonic gel was applied to the electrodes to increase the conductiveness. Then the electrodes were placed over the posterior aspect of the patient's leg over the calf area and fastened with Velcro straps (Fig-1).

The frequency was set to 100 Hz with a pulse width of 0.3 millisecond. The intensity was raised up to the patient's tolerable limit. Thus High frequency TENS was given to the group I patients for 20 minutes continuously.

The patient was promptly advised to intimate the therapist if they felt any discomfort during the treatment. Following the TENS application, passive movement was given to the ankle joint of the patient. Sticking with the same pattern, this form of treatment was given to the patients for eight weeks continuously such that the subject was treated for six days a week.

For **Group B**, continuous passive stretching was given (Fig-2). Following preparation of the patient, they were positioned comfortably in the couch with soft mattress.

The patient was positioned in supine and the therapist was standing beside the affected side of the patient. Having positioned himself in a biomechanical effective manner, the therapist clutched the heel of the patient's affected ankle and gradually performed the stretching.

Stretching was performed for the plantar flexors so as to maintain the ankle in the dorsiflexed position. The stretch was sustained for 30 seconds with a rest period of 30 seconds. Similarly 20 cycles were done for twenty minutes. If full range was not able to achieve for few patients then available range was utilized to stretch it with gradual progression during the successive days.

Following this period, the patient was given passive movements to the ankle joint for five minutes. This pattern of treatment was given six days a week for a period of eight weeks.

Following the eight weeks protocol, patients of each group was individually assessed and the parameters were recorded. The Modified Ashworth's scale was used to measure the degree of spasticity for the patients, to assess this, the patient was asked to lie down on a couch in a relaxed position and the affected lower limb was moved passively. The resistance encountered by the therapist to passive movement was then recorded as the grade of spasticity. It was compared with the pre-treatment measurement. The same grading was taken in between the study period also at the end of third week.

The recordings were subjected to statistical analysis and the results of that were interpretated to obtain the significance of the study.

Figure – 1 Group A Patient treated with TENS

Figure – 2 Group B patient treated with Passive Stretching

3.8 STATISTICAL TOOL

The statistical tools used in this study were **paired t-test** and **unpaired t-test**. The paired t-test used to find out a statistical significance between pre-test and post-test of patients treated with TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION and PASSIVE STRETCHIN on Group A and Group B individually.

Paired t-test:

$$S = \sqrt{\frac{\sum d^2 - (\sum d)^2/n}{n-1}}$$

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

$\bar{d}$ = mean difference

n= total number of subjects

s=standard deviation.

Unpaired t-test

The unpaired t-test is used to compare the statistical significant between Group A and Group B.

$$S = \sqrt{\frac{(n_1-1)s_1 2+ (n_2-1)s_2 2}{n_1 + n_2-2}}$$

N_1=total number of subjects in Group A

N_2=mean difference between pretest/post test Group B.

$$t = \frac{|\bar{X}_1 - \bar{X}_2|}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$\bar{X}_1$ = mean difference between pre-test/post-test of Group A.

$\bar{X}_2$= mean difference between pre-test/post-test of Group B.

4. DATA PRESENTATION

Pre test and Post test values using Modified Ashworth Grades of spasticity

Group –A (TENS)

Table - 1

Sl. No	Pre-test	Post-test
1	4	3
2	3	2
3	5	4
4	2	1
5	3	2
6	4	3
7	3	3
8	5	5
9	4	4
10	4	3

Pre test and Post test values using Modified Ashworth Grades of spasticity

Group –B (PASSIVE STRECHING)

Table - 2

Sl. No	Pre-test	Post-test
1	5	3
2	4	2
3	5	3
4	3	1
5	4	2
6	4	2
7	3	1
8	2	1
9	5	3
10	3	2

5. DATA ANALYSIS AND INTETRPRETATION

DATA ANALYSIS OF PRE AND POST TEST SCORES OF GROUP A

This chapter deals with analysis and interpretation of data collected from 20 patients with Plantarflexor tightness. The value of MAS Score is used to compare the efficacy of TENS versus PASSIVE STRECHING in the management of Plantar Flexor Spasticity in Stroke.

Table - 3

VALUES	**GROUP A TENS**	
GROUP 'A' MEAN VALUE	A PRE TEST	A POST TEST
	3.70	3.00
Standard Deviation	0.95	1.15
Paired 't' test value	4.5826	
'p' value & Significance	P Value < 0.05 significance	

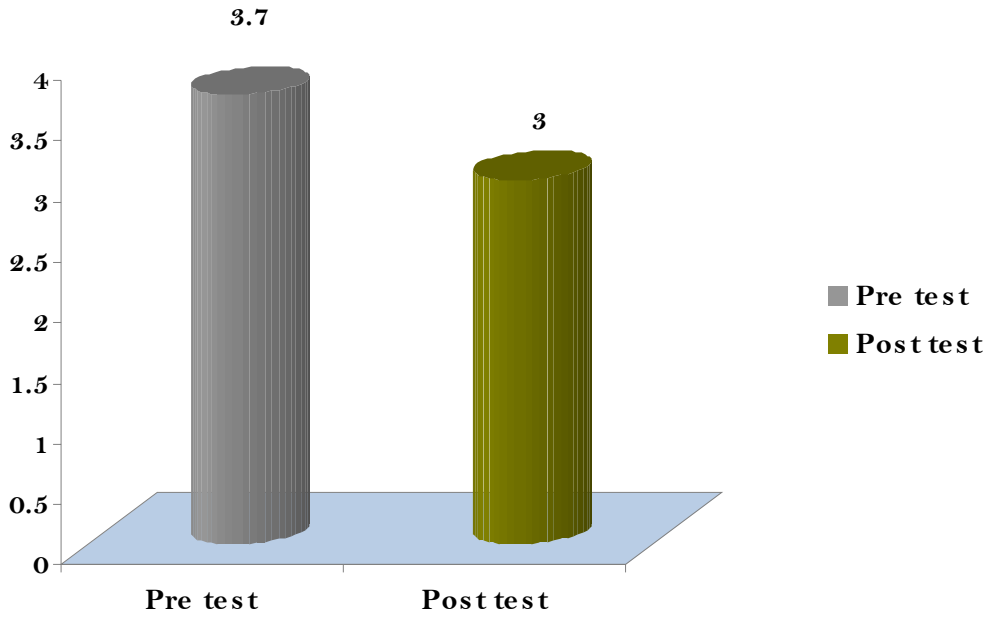
Table- 3 shows the comparative mean value, mean difference, standard deviation and Paired't'-value between Pre versus post-test of group A

It explains,

The paired‘t’ value of 4.5826 is greater than the tabulated ‘t’ value 0.01, which showed that there is statistical significant difference at 0.05 levels between pre versus post-test results. The pre-test mean is 3.700 and the post test mean is 3.00 and their mean difference is 0.700, which is response to transcutaneous electrical nerve stimulation given to the hemiplegic patients after 8 weeks of treatment.

GRAPH I

PRE AND POST TEST SCORES OF GROUP A



The mean value of pre and post test values of Group A

DATA ANALYSIS OF PRE AND POST TEST VALUES OF GROUP B

Table - 4

VALUES	**GROUP B** **Passive Stretching**	
GROUP 'B' MEAN VALUE	PRETEST	POST TEST
	3.800	2.000
Standard Deviation	1.033	0.782
Paired 't' test value	11.7838	
'p' value & Significance	P Value < 0.05 significance	

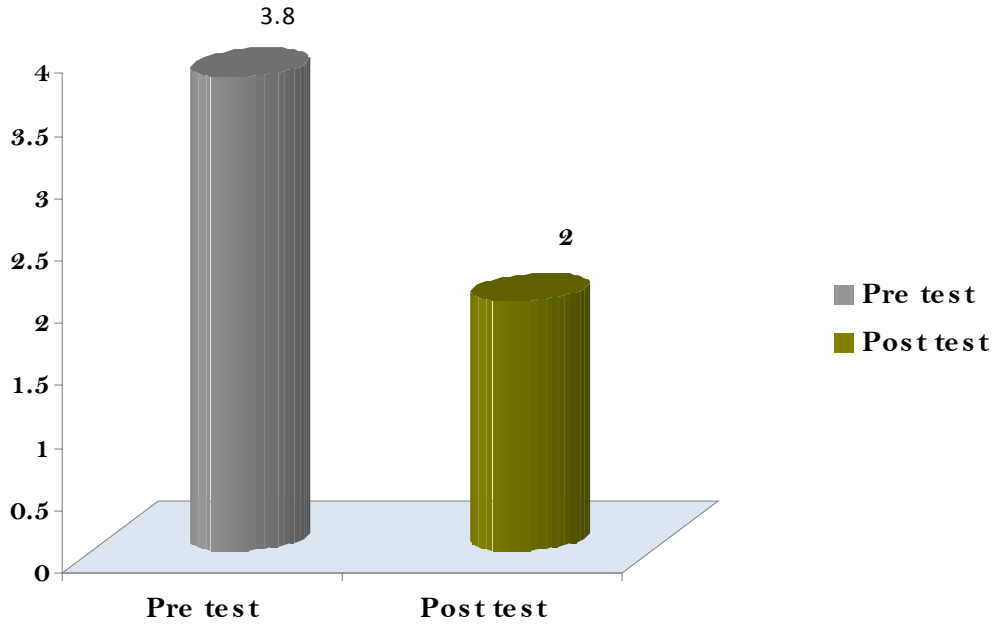
Table- 4 shows the comparative mean value, mean difference, standard deviation and Paired't'-value between Pre versus post-test of group B

It explains,

The paired't' value of 11.7838 is greater than the tabulated't' value 0.001, which showed that there is statistical significant difference at 0.05 levels between pre versus post-test results. The pre-test mean is 3.800 and the post test mean is 2.000 and their mean difference is 1.8, which is in response to the passive stretching given to the hemiplegic patients after 8 weeks of treatment.

GRAPH II

PRE AND POST TEST VALUES OF GROUP B



The mean value of pre and post test values of Group B

DATA ANALYSIS OF POST TEST VALUES OF

GROUP A AND GROUP B

Table - 5

VALUES	**TENS Vs Passive Stretching**	
Post test mean Values	Group A	Group B
	3.000	2.000
Standard Deviation	1.15	0.82
Independent ‘t’ test value	2.2361	
‘p’ value & Significance	P Value < 0.05 significance	

Table- 5 shows the comparative mean value, mean difference, standard deviation and Unpaired‘t’-value between Group A and Group B.

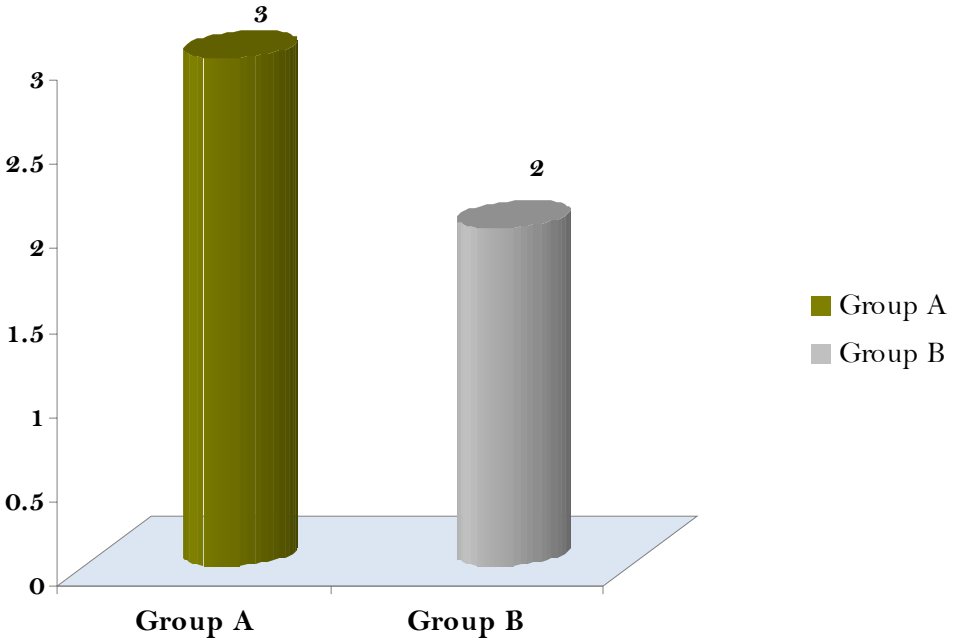
It explains,

The unpaired‘t’ value of 2.2361 is greater than the tabulated ‘t’ value 0.05, which showed that there is statistical significant difference at 0.05 levels between mean of **Group A** 0.70. The pre-test versus post-test mean of Group B is 1.80 and their mean difference is 1.10, there is significant difference in MAS grades in both groups, so we accept alternate hypothesis rejecting null hypothesis.

GRAPH-3

POST TEST VALUES OF

GROUP A AND GROUP B



The mean value of post test value of Group A and B

6. DISCUSSION

In this study, totally 20 subjects were selected and assigned randomly to two groups of 10 subjects each who received TENS (Group A) and Passive Stretching (Group B) respectively. Both the groups received conventional physiotherapy that is passive movement in common after that.

The two groups were analyzed with the spasticity grade as the parameter which was assessed using Modified Ashworth's Scale. The mean was calculated and the statistical analysis of the values showed considerable increase in the mean improvement for the Group B than the Group A which proved that the subjects who received Passive Stretching had a better outcome than the subjects who received Transcutaneous Electrical Nerve Stimulation.

The study undertaken includes patients with hemiplegia who falls under Brunnstorm's classification stage of III & IV. Hence this study can't be generalized to whole population with hemiplegia. Although many treatment methods are currently in vogue in order to deal these kinds of patient's need. The growing demand for meeting various problems associated with spasticity is indeed worth considering.

This study could be one of the corner stones for tackling spasticity and its associated problems. This study was based on the information got from

many reviews and seemed to be the first investigative analysis to find out the effectiveness between two groups and the findings indicate that the Group B showed a better improvement than Group A.

This study was localized to plantarflexors (Gastrocnemius and Soleus) as that was the significant muscle with increased muscle tone in antigravity muscles of lower limb which is well pronounced in stroke or any other upper motor neuron lesion patients.

The study was detailed and tailored to find the efficacy of which mode of treatment was better in the two groups. Overall, 10 patients received TENS and 10 received passive stretching both were selected based on the inclusion criteria for evaluating the patients according to the Brunnstorm's stages of hemiplegia.

Theses results were significant at $p > 0.05$ that is both TENS and passive stretching were optimum to facilitate reduction in spastic muscles. These results strongly support the earlier findings of Tekeoglu Y et al (1998) in which they proposed that TENS reduce spasticity. Also studies done by Eadric Bressel et al (2002) support our results that there is a reduction of increased tone in muscles by means of passive stretching.

This study was been done with both male and female subjects so that there would have be a chance of comparing both the sexes. Both the groups were detailed down to see how they were responding to the treatment and both showed considerable zest in following the protocol and found reduction in their increased tone and had a better and profound outcome in their desired activities.

The results of the present study indicate that TENS and Passive stretching were effective in reducing spasticity. The choice between these two Protocols should be based on physiotherapist and patient comfort. Hope this study will encourage most of the physiotherapist who are good at passive stretching and in application of TENS.

7. SUMMARY

A prospective study of twenty Hemiplegic subjects was undertaken to determine the effect of TENS and Passive Stretching in reducing spasticity. Both the intervention was found to have a cumulative effect on reducing spasticity while the group B is showing better improvement than Group A. The choice of treatment for these patients varies with the physiotherapist knowledge and his choice of the treatment protocol.

8. CONCLUSION

Twenty hemiplegic subjects were designated for this study with age limit between (50 – 60years) and divided into two groups Group A (n=10) was given TENS and Group B (n=10) was treated with Passive Stretching. Group B shows better improvement than Group A. In Group A, TENS was given for 20 minutes and in Group B Passive Stretching was given for the same 20 minutes (with a hold period of 30seconds and a rest period of 30 seconds).

Overall with the study done and data analyzed, and Passive Stretching was found to be efficient than TENS in the rehabilitation procedures involving patients with neurological impairments associated with spasticity. Indeed it requires a high deal of endurance and patience from both the therapist and the patient to achieve the desired effect.

9. LIMITATIONS OF THE STUDY

1. The sample size in this study was small, larger sample was not taken.
2. This study was done in hemiplegic subjects especially for the spasticity of the muscles of the lower limb and upper limbs muscles were not considered.
3. In this study subjects were tested only on those who presented with extensor type of spasticity in the lower limbs.
4. Only one parameter, the spasticity grade assessed using Modified Ashworth's Scale was used in this study.
5. The hemiplegic subjects graded as recovery stages III & IV alone were Selected for this study.

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11. APPENDIX

ANNEXURE-1

ASSESSMENT FORMAT

Demographic Data

Name :

Age :

Sex :

Occupation :

Address :

History :

Present medical history :

Duration of stroke :

Side of involvement :

Type of stroke :

Territory of involvement:

Past medical history

Prior history of CVA :

Hypertension :

Diabetes mellitus :

Orthopedic disorders :

Visual problems :

Personal history :

Socioeconomic history:

Previous therapies taken:

On observation

General condition :

Attitude of limbs-Lower limb:

Wasting if any :

On palpation

Tenderness :

On examination

Level of consciousness:

Cranial Nerve examination:

Higher Mental functions:

Appearance -

Behavior -

Intelligence -

Judgment -

Memory -

Orientation -

Speech and language -

Perception -

Sensory Examination

Superficial : Touch, pressure & pain.

Deep : Position sense, kinesthetic sense & Vibration.

Cortical : Stereognosis, Barognosis, Tactile localization

Tactile discrimination & Two point discrimination.

Motor Examination

ROM : Lower limb

Hip

Flexion -

Extension-

Abduction-

Adduction-

Medial Rotation

Lateral Rotation -

Knee

Flexion -

Extension -

Ankle

Plantarflexion-

Dorsiflexion -

Inversion-

Eversion -

Tightness :

Contracture :

Deformity :

Reflexes

Knee jerk :

Ankle jerk :

MMT

Plantarflexors

Gait Assessment :

Bladder and bowel:

Functional assessment

ADL :

Eating -

Grooming -

Toileting -

Bathing -

Bed mobility -

Ambulation -

Stage of Hemiplegia : (Based on Brunnstorm stages of Recovery)

DATA COLLECTION TABLE

Sl. No.	Pre-test	Post-test
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

ANNEXURE-2

CONSENT FORM:

This is to certify that I _____ freely & voluntarily agree to participate in the study "_____".

I have been explained about the procedures & the risks that would occur during the study. Questions have been answered to my satisfaction.

Participant :

Witness :

Date :

I have explained & defined the procedure to which the subject has consented to participate.

Researcher :

Date :

ANNEXURE-3

BRUNNSTORM STAGES

SEQUENTIAL RECOVERY STAGES IN HEMIPLEGIA

STAGE 1: Recovery from Hemiplegia occurs in a stereotyped sequence of events that begin with a period of flaccidity immediately following the acute episode. No movement of the limbs can be elicited.

STAGE 2: As recovery begins, the basic limb synergies or some of their components may appear as associated reactions, or minimal voluntary movement responses may be present. At this time, spasticity begins to develop.

STAGE 3: Thereafter, the patient gains voluntary control of the movement synergies, although full range of all synergy components does not necessarily develop. Spasticity has further increased and may become severe.

STAGE 4: Some movement combinations that do not follow the paths of either synergy are mastered, first with difficulty, then with ease and spasticity begins to decline.

STAGE 5: If progress continues, more difficult movement combinations are learned as the basic limb synergies lose their dominance over the motor acts.

STAGE 6: With the disappearance of the spasticity, individual joint movements become possible and coordination approaches normal. From here on as the last recovery step, normal motor function is restored, but this last stage is not achieved by all, for the recovery process can plateau at any stage.

ANNEXURE-4

Modified Ashworth Scale for grading Spasticity

GRADE	DESCRIPTION
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release, Or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
2	Slight increase in muscle tone, manifested by a catch, followed by Minimal resistance throughout the remainder (less than half) of the range of movement (ROM)
3	More marked increase in muscle tone through most of ROM, but Affected part(s) easily moved
4	Considerable increase in muscle tone, passive movement difficult to perform.
5	Affected part(s) rigid in flexion and extension